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HS1231

Compact Growth Habit Tomatoes[1]

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Introduction

Nationally, Florida ranks first in fresh-market tomato (*Solanum lycopersicum*) production value with an average crop value of US$481 million over the last six years [U.S. Department of Agriculture (USDA), 2010, 2013]. In the 2012 season, Florida had the second largest fresh-market tomato acreage in the United States with 29,000 acres harvested and an average yield of 33,000 lb/acre resulting in almost 1 billion pounds of tomato fruit (USDA, 2013).

Wild tomato species are native to western South America from southern Ecuador to northern Chile and the Galapagos Islands (Peralta and Spooner, 2007). Tomato domestication occurred in America (Bai and Lindhout, 2007); however, the first domestication site is still not defined, with two hypotheses, a Peruvian domestication and a Mexican domestication, being considered (Peralta and Spooner, 2007). Regardless of controversies related to the first domestication site and early history, tomatoes were first recorded outside the American continent in Italy in 1544 (Peralta and Spooner, 2007). Tomatoes were first cultivated as ornamental plants due to people's beliefs that the fruit were poisonous. The acceptance of tomato as an edible vegetable occurred during the late 16th century in southern Europe (Peralta and Spooner, 2007). Ever since, plant breeding has provided diversity of tomato types and varieties derived from the original lines, and the majority of the varieties currently grown are hybrids with a wide range of shapes, colors, and sizes (Bai and Lindhout, 2007).

The most common types of tomatoes planted in Florida are round, roma, cherry, and grape. The majority of the round and roma tomato cultivars grown in Florida are determinate plants with upright growth, which cease their growth when fruit set on the apical meristems (Ozores-Hampton et al., 2011). These tomatoes are commonly harvested at mature-green stage for the fresh market. Lodging of determinate upright tomatoes can reduce tomato fruit yield and quality (Adelana, 1980), thus commercial hybrids that grow vertically to a certain height and then fall over require staking; if not staked, the vines would typically grow off the beds and into the aisles, where they could be run over by a tractor and where the fruit could be subject to rots from soil-borne pathogens. According to Davis and Estes (1993), labor costs related to practices such as transplanting, staking, pruning, tying, and harvesting may be as high as 55% of the total tomato production cost, which was estimated at $16,259/acre in 2008 for southwest Florida (VanSickle et al., 2009). In addition to the labor costs, availability of farm labor and immigration issues are major concerns to the Florida tomato industry (McAvoy and Ozores-Hampton, 2011; Scott et al., 2010). Mexican tomatoes may be produced at a reduced cost because of the lower labor and land costs when compared to the Florida tomato industry (McAvoy and Ozores-Hampton, 2011). Therefore, alternatives to the traditional production system that reduce production cost would be economically beneficial to the Florida tomato industry.

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Alternative tomato production systems that do not require staking, tying, and pruning have been used successfully by the California tomato industry for both processing and part of their fresh-market tomato production. The California processing tomato industry uses determinate varieties with a controlled growth habit (S. Schroeder, personal communication). These tomatoes are once-over mechanically harvested when 90% of the fruits are ripe (Hartz et al., 2008). California fresh-market tomato growers use two different growing methods: staked upright or bush varieties, with bush hybrids constituting the majority of the market (Le Strange et al., 2000). Bush hybrid tomatoes are harvested manually one or two times at the mature-green stage (Le Strange et al., 2000).

Compact growth habit (CGH) tomatoes are determinate varieties with a unique architecture that may provide the basis for a viable alternative production system for Florida. These tomatoes have low growth and spreading characteristics, forming compact plants that hold fruit above the ground due to its short branches (Kemble et al., 1994) (Figure 1). Therefore, CGH tomatoes do not require staking, tying, or pruning (Kemble et al., 1994). Thus, due to their unique plant growth, CGH varieties may be used by the Florida mature-green fresh-market tomato growers to reduce labor costs associated with staking, tying, and pruning.

Figure 1. Compact growth habit tomatoes (four center beds) growing in Immokalee, FL.
Credits: Aline Coelho Frasca

Genetics and morphology

Compact growth habit plants have determinate vines with a compact plant structure. Several genes have been reported to affect tomato plants' growth habit and/or branching (Ozminkowski et al., 1990a), such as decumbens *(dec)* (Stubbe, 1959), procumbens-2 *(prc-2)* (Stubbe, 1960), and brachytic *(br)* (Barton et al., 1955). Increased side branching has been related to the genes erecta-2 *(er-2)* (Clayburg et al.,1979), globiformis *(glf),* and globosa-2 (glo-2) (Clayburg et al.,1966) and also to reduced apical dominance (Campbell and Nonnecke, 1974). The *br* gene (Barton et al., 1955) is the one responsible for the shortened internodes and strong side branching of CGH plants, which can be prostrate or upright in growth due to unidentified gene(s) (Ozminkowski et al., 1990b). This combination of traits results in a low-growing, spreading plant, approximately 24 inches in diameter with a reduction of 50% to 60% in internode length compared to staked upright varieties (Kemble et al., 1994) (Figure 2).

Figure 2. Compact growth habit plant grown in Immokalee, FL. Arrows indicate shortened internodes.
Credits: Aline Coelho Frasca

Similar to normal growth habit tomatoes, each short branch, including the terminal bud, terminates in a flower cluster in CGH plants; however, CGH plants develop a more concentrated fruit set that is early in maturity. The average height of CGH plants ranges from 19 to 21 inches and average plant volume is approximately 8.9 ft^3 (A. Coelho Frasca and M. Ozores-Hampton, unpublished data). When in the field, plants of CGH tomatoes cover the polyethylene-mulched bed but will not grow into the row middles, holding most of the fruit above the bed surface (Scott et al., 2010) (Figure 3).

Figure 3. Compact growth habit tomato (top) and staked upright tomato (bottom) growing in Immokalee, FL.
Credits: Aline Coelho Frasca

Production

Compact growth habit tomato varieties with jointless pedicels that would be commercially acceptable have not been completely developed for the Florida market at this time, but progress is being made. Since the fruit set is concentrated and all fruit may be harvested at one time, it is particularly important to ensure that the varieties are not prone to fruit defects such as cat facing or gray wall. In addition, fertilization programs are critical for CGH varieties because it is important to get crown fruit set to maintain a proper reproductive/vegetative balance. High nitrogen levels may cause excessive vegetative growth and consequently low yields and can also contribute to the defects mentioned above. Perception of lower yield potential may be attributed to the growth characteristic of these tomato plants that lie on the polyethylene-mulched bed, which, combined with high temperatures and relative humidity, may favor the proliferation of plant pathogens under typical Florida weather conditions. However, there is no evidence that yields are reduced by plant pathogens when CGH plants are grown in Florida environmental conditions. In order to minimize the effect of weather-related issues, alternative production systems can be developed for CGH varieties, including factors that influence plant growth and development such as bed configuration, spacing, and row arrangements (Davis and Estes, 1993).

Harvest

In Florida, the majority of fresh-market tomatoes are hand-harvested at the mature-green stage with specific criteria for size, shape, color, and defects (USDA, 1997). Compact growth habit tomatoes can be harvested by hand or potentially mechanically harvested when the plants have the jointless-pedicel characteristic, eliminating the need for expensive hand-harvesting labor (Scott et al., 2010). In jointless varieties, when the fruits are harvested the calyx and stem remain attached to the plant, whereas in jointed varieties, part of the stem and the calyx often remain attached to the fruit (Zahara and Scheuerman, 1988). Due to unknown environmental conditions, stems and calyxes are sometimes difficult to pry off fruit, especially for some cultivars. Stems that remain attached to fruit of jointed tomatoes at harvest may puncture or bruise other fruit during transportation and packing, affecting quality. In addition, hand harvest of jointed cultivars requires additional time for workers to remove stems and calyxes in order to avoid fruit damage, which increases labor costs (Zahara and Scheuerman, 1988).

Compact growth habit tomatoes generally reach maturity one to two weeks earlier than typical staked varieties. In addition, manual harvest can be done once or twice in CGH tomatoes because they have a concentrated fruit set, reducing the harvesting cost when compared to the currently staked-upright tomato varieties that are generally harvested three times. Thus, CGH tomatoes can reduce the time from transplant to final harvest by approximately one month as compared to the currently staked-upright varieties. Therefore, total production costs would be lower than current commercial upright tomatoes. Ultimately, CGH tomato cultivars could be once-over harvested by machine, which would further reduce harvest costs, although there would be considerable costs in purchasing harvest machine(s).

Conclusion

Compact growth habit tomato varieties are not currently available for the Florida market, but the University of Florida Tomato Breeding Program is working on the development of breeding lines suitable for the mature-green fresh market. The unique plant architecture of CGH tomatoes may be used by Florida fresh-market tomato growers as an alternative production system to reduce labor costs associated with staking, tying, and pruning. Furthermore, CGH tomatoes with the jointless-pedicel characteristic may be mechanically harvested, reducing costs associated with manual harvest.

Literature cited

Adelana, B.O. 1980. Relationship between lodging, morphological characters and yield of tomato cultivars. Scientia Hort. 13:143-148.

Bai, Y. and P. Lindhout. 2007. Domestication and breeding of tomatoes: what have we gained and what can we gain in the future? Ann. Bot. 100:1085–1094.

Barton, D.W., L. Butler, J.A. Jenkins, C.M. Rick, and P.A. Young. 1955. Rules for nomenclature in tomato genetics (including a list of known genes). J. Hered. 46:22-26.

Campbell, C.G. and I.L. Nonnecke. 1974. Inheritance of an enhanced branching character in tomato *(Lycopersicon esculentum* Mill.). J. Amer. Soc. Hort. Sci. 99:358-360.

Clayburg, C.D., L. Butler, E.A. Kerr, C.M. Rick, and R.W. Robinson. 1966. Third list of known genes in tomato (with revised linkage map and additional rules). J. Hered. 57:188-196.

Clayburg, C.D., L. Butler, E.A. Kerr, C.M. Rick, and R.W. Robinson. 1979. Report of gene list committee. Tomato Genet. Coop. 29:2-17.

Davis, J.M. and E.A. Estes. 1993. Spacing and pruning affect growth, yield, and economic returns of staked fresh-market tomatoes. J. Amer. Soc. Hort. Sci. 118:719-725.

Hartz, T., G. Miyao, J. Mickler, M. Le Strange, S. Stoddard, J. Nunez, and B. Aegerter. 2008. Processing tomato production in California. Univ. California, Veg. Res. and Info. Ctr. Pub. 7228. 14 Aug. 2013. http://www.anrcatalog.ucdavis.edu/pdf/7228.pdf

Kemble, J.M., J.M. Davis, R.G. Gardner, and D.C. Sanders. 1994. Spacing, root cell volume, and age affect production and economics of compact-growth-habit tomatoes. HortScience 29:1460-1464.

Le Strange, M., W.L. Schrader, and T.K. Hartz. 2000. Fresh-market tomato production in California. Univ. California, Veg. Res. and Info. Ctr14 Aug. 2013. http://anrcatalog.ucdavis.edu/pdf/8017.pdf

McAvoy, E. and M. Ozores-Hampton. 2011. Unique challenges for Florida growers in tomato and pepper production. Univ. Florida, IFAS, EDIS Circ. IPM-201. 14 Aug. 2013. http://edis.ifas.ufl.edu/in733

Ozminkowski, Jr., R.H., R.G. Gardner, R.H. Moll, and W.R. Henderson. 1990a. Inheritance of prostrate growth habit in tomato. J. Amer. Soc. Hort. Sci. 115:674-677.

Ozminkowski, Jr., R.H., R.G. Gardner, W.R. Henderson, and R.H. Moll. 1990b. Prostrate growth habit enhances fresh-market tomato fruit yield and quality. HortScience 25:914-915.

Ozores-Hampton, M., E. McAvoy, S.M. Olson, K. Cushman, and N. Roe. 2011. Tomato varieties for Florida – Florida "red rounds", plum, cherries, and grapes. Univ. Florida, IFAS, EDIS Circ. HS1189. 14 Aug. 2013. http://edis.ifas.ufl.edu/hs1189

Peralta, I.E. and D.M. Spooner. 2007. History, origin and early cultivation of tomato (solanaceae), p. 1-27. In: M.K. Razdan and A.K. Mattoo (eds.). Genetic improvement of Solanaceous crops. Sci. Publishers, Enfield, NH.

Scott, J.W., S.F. Hutton, and J. Strobel. 2010. Some highlights from the University of Florida tomato breeding program. Proc. Florida Tomato Inst. 53:9-10.

Stubbe, H. 1959. Mutanten de kulturtomate *Lycopersicon esculentum* Mill. III. Kulturpflanze 7:82-112.

Stubbe, H. 1960. Mutanten der wildtomate *Lycopersicon pimpinellifolium* (Jusl.). Mill. II. Kulturpflanze 8:110-137.

U.S. Department of Agriculture. 1997. United States standards for grades of fresh tomatoes. 14 Aug. 2013. http://www.ams.usda.gov/getfile?dDocName=STELPRDC5050331

U.S. Department of Agriculture. 2010. Vegetables 2009 summary. 14 Aug. 2013. http://usda01.library.cornell.edu/usda/nass/VegeSumm//2010s/2010/VegeSumm-01-27-2010.pdf

U.S. Department of Agriculture. 2013. Vegetables 2012 summary. 14 Aug. 2013. http://usda01.library.cornell.edu/usda/current/VegeSumm/VegeSumm-01-29-2013.pdf

VanSickle, J., S. Smith, and E. McAvoy. 2009. Production budget for tomatoes in southwest Florida. Univ. Florida, IFAS, EDIS Circ. FE818. 14 Aug. 2013. http://edis.ifas.ufl.edu/fe818

Zahara, M.B. and R.W. Scheuerman. 1988. Hand-harvesting jointless vs. jointed-stem tomatoes: jointless-stem fresh-market varieties take much less time to pick than jointed types. Univ. California, Veg. Res. and Info. Ctr 14 Aug. 2013. http://ucce.ucdavis.edu/files/repositoryfiles/ca4203p14-68779.pdf